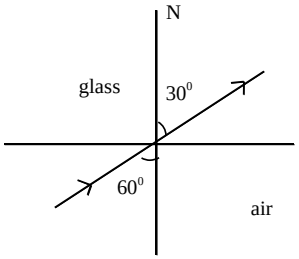
SRIGAYATRI EDUCATIONAL INSTITUTIONS

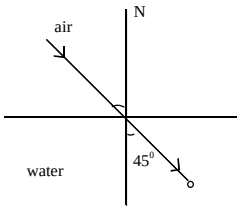
INDIA

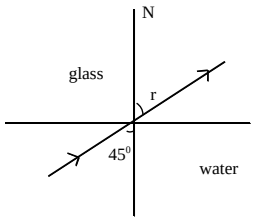
SR MPC JEE MAINS (UT1)– QUESTION BANK
RAY OPTICS

1. An object is placed at 15cm in front of a concave mirror of radius of curvature 20cm.Find the position, nature and magnification of the image in each case.
   1) m=3;real and inverted 2) m=3; virtual inverted
   3) m=-2;real&inverted 4)m=-2;virtual&inverted
   Ans:3
   Sol: $u=-15cm$
   $R=20cm$
   $f=-10cm$ $\left|\begin{array}{l}\frac{1}{v}+\frac{1}{u}=\frac{1}{f}\\ v=-30cm\end{array}\right|$ $m=\frac{-v}{4}=-2$
2. Light from a point source in air falls on a spherical glass surface (n=1.5 and radius of curvature=15cm).The distance of the light source from the glass surface is 75cm.At what position the image is formed?
   1)-25cm 2)25cm 3)30cm 4)-30cm
   Ans:1
   Sol: $\frac{M_2}{v}-\frac{M_1}{u}=\frac{M_2-M_1}{R}$
   $M_1=1$
   $M_2=1.5$
   R=15cm
   $u=75cm$
3. A convex lens has 25cm focal length in air. what is focal length in water? (reflective index of air water=4/3,reflective index for air-glass=3/2)
   1)50cm 2)100cm 3)150cm 4)25cm
   Ans: 2
   Sol: $\frac{1}{l}=\left(\frac{ML}{Mg}-1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$
4. What focal should the reading spectacles have for a person for whom the least distance of distinct vision is 100cm?
   1) $\frac{200}{3}cm$ 2)50cm 3) $\frac{100}{3}cm$ 4)150cm
   Ans:3
   Sol: $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$ $u=-25cm$
   $v=-100cm$

5. Show reflection of a ray in air incident at with the normal to a glass-air and water-air interface respectively. Predict the angle of refraction in glass when the angle of incidence in water is with the normal to a water-glass interface







1) 30^0 2) 45^0 3) 90^0 4) 38^0

Ans:1

Sol: Snell's law

$\mu_1 \sin i = \mu_2 \sin r$

$u_g = ?$

$uw = ? r = ?$

6. A small bulb is placed at the bottom of a tank containing water to a depth of 80 cm what is the are of the source of water through which light from the bulb can emerge out? Refractive index of water (consider the bulb to be a point source).

1) $1.6\,m^2$ 2) $3.6\,m^2$ 3) $0.26\,m^2$ 4) $2.6\,m^2$

Ans:4

Sol: $\tan c = \frac{r}{h}$

$r = h\,tanC$

$r = \frac{h}{\sqrt{\mu^2 - 1}}$

$A = \frac{\pi h^2}{\mu^2 - 1}$

7. An object of size 7cm is placed 14 cm in front of a concave lens of focal length 21 cm. Describe the image produced by the lens. What happens if the object is moved further away from the lens?

1)2.4cm 2)4.2cm 3)1.8cm 4)3.8cm

Ans: 2

Sol: $\frac{1}{v} \in t$

$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\frac{1}{v} + \frac{1}{14} = \frac{-1}{21}$

$\frac{1}{v} = \frac{-1}{21} - \frac{1}{14}$

V=-8.4cm

$m = \frac{-v}{u} = \frac{hi}{h_0}$

8. A small pin fixed on a table top is viewed from above from a distance of 50cm by what distance would, the pin appear to be raised if it is viewed from the same point through a 18cm thick glass slab held parallel to the table ? Refractive index of glass=1.5 does the answer depend on the location of the slab?

1)6cm 2)12cm 3)6m 4)12m

Ans:1

Sol: Apparent dept= $\frac{\text{Real depth}}{\frac{\mu g}{\mu i}} = \frac{18}{3} = 12cm$

Normal shift d=18-12=6cm

9. A myopic person has been using spectacles of power -1.0 dioptre for distant vision. During old age he also needs to use separate reading glass of power +4/3 D. Explain what may have happened.

1)+37.5cm 2)50cm 3)-37.5cm 4)-50cm

Ans:3

Sol: near point in normal $u = -25cm$

The old age the person use $+\frac{4}{3}D$

$$f = \frac{100}{\frac{4}{3}} = 75cm$$

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{4}$$

$$v = -37.5cm$$

10. A man with normal near point (25cm) reads a book with small print using a magnifying glass a thin convex lens of focal length 5cm What is the closest and the farthest distance at which he should keep the lens from page so that he can read the book when viewing through the magnifying glass?

1)-4.2 cm and +5cm 2) +4.2cm and -5cm 3)-5cm and -4.2 cm 4)-4.2cm and -5cm

Ans:4

Sol: Near distance

v= -2.5 cm

$f = +5cm$

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

$u = -4.2cm$

Farther distances

$v = \infty$

$f = 5cm$

$u = -5cm$

11. A small telescope has an objective lens of focal length 120 cm and an eyepiece of focal length 5 cm. what is the magnifying power of the telescope for viewing distant objects when The telescope is in normal adjustment (i.e when the final image is formed at the least distance of distinct vision.

1)28.8 2)33.6 3)2.88 4)3.36

Ans:1

Sol: $m = \frac{fo}{fe}\left[1 + \frac{fe}{d}\right]$ $fo = 120cm$

$fe = 5cm$

$$m = \frac{120}{5}\left[1 + \frac{5}{25}\right] = 28.8$$

12. A boy of height 1 m standard in front of a convex mirror his distance from the mirror is equal to its focal length. The height of his image is

1)0.25m 2)0.33m 3)0.5m 4)0.67m

Ans:3

Sol: $u=-f$

$f=+f$

$\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$

$v=\frac{f}{2}$

$m=-\frac{v}{u}$

$m=\frac{1}{2}=0.5$

$m=\frac{hI}{ho}$

$hI=+ho=0.5m$

13. A apparent depth of a needle lying at the bottom of the tank. which is filled with water of refractive index 1.33 to a height of 12.5cm is measured by a microscope to be 9.4cm.If water is replaced by a liquid of refractive index 1.63 upto the same height, what distance would the microscope have to be moved to focus on the needle lying

1)1.73cm 2)2.13cm 3)1.5cm 4)2.9cm

Ans:1

Sol: Apparent depth= $\frac{\text{Re}\,al\ depth}{\mu}$

Real depth=12.5cm

$\mu=1.63$

Apparent depth= $\frac{12.5}{1.63}=7.67cm$

Shift distance

=9.4-7.67=1.73cm

14. Critical angle for light going from medium (A) to (B) is θ.The speed of light in medium (A) is v,then the speed of light in medium (B) is

1) $v(1-\cos\theta)$ 2) $\frac{v}{\sin\theta}$ 3) $\frac{v}{\cos\theta}$ 4) $\frac{v}{(1-\sin\theta)}$

Ans:2

Sol: Snell's law

$\sin\theta=\frac{\mu_B}{\mu_A}=\frac{v_A}{v_B}$

$v_A=v$

$v_B=?$

$v_B=\frac{v_A}{\sin\theta}$

15. A convex lens of focal length 0.2m and mode of glass $\left({}^a\mu_g=1.5\right)$ is immersed in water $\left({}^a\mu_w=1.33\right)$, The change in the focal length of the lens is

1)5.8m 2)0.58cm 3)0.58m 4)5.8cm

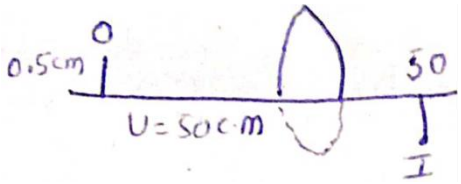
Ans:3

Sol: $\frac{1}{f}=\left(\frac{M_2}{M_1}-1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

$$\frac{f_w}{f_{air}}=\frac{\left(\frac{\mu_L}{\mu_{air}}-1\right)}{\left(\frac{\mu_L}{\mu_{water}}-1\right)}$$

Change in focal length of the lens is $f_w - f_{air} = 0.58m$

16. A thin convex lens of focal length 25 cm is cut into two pieces 0.5cm above the principal axis. The top part is placed at (0,0) and an object placed at(-50cm,0).The coordinates of image are
1)50cm,-2cm 2)(50cm,-1cm) 3)(3cm,-50cm) 4)(60cm,-25cm)
Ans:2
Sol: If there was no cut

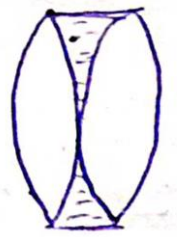


$$\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$$
$$\frac{1}{f}+\frac{1}{u}=\frac{1}{v}$$
$$\frac{1}{v}=\frac{1}{25}+\frac{1}{-50}$$
$$v=50cm$$
$$m=-\frac{v}{u}=-1$$

The image it would have been formed 50cm from the pole and 0.5cm below the axis

17. Two identical glass $\left(\mu_g=\frac{3}{2}\right)$ equi convex lenses of focal length fare kept in contact. The space between the two lenses is filled with water $\left(\mu_w=\frac{4}{3}\right)$.The focal length of the combination is
1) f 2) f /2 3) $\frac{4f}{3}$ 4) $\frac{3f}{4}$
Ans:4

Sol: $\frac{1}{f}=\left(\frac{\mu_L}{\mu_{air}}-1\right)\left(\frac{1}{R_1}+\frac{1}{R_2}\right)$



$$\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}+\frac{1}{f_3}$$
$$f_1=f_2=f$$

The water lens

$$\frac{1}{f_3}=\left(\frac{\mu_w}{\mu_a}-1\right)\left(-\frac{1}{R}-\frac{1}{R}\right)$$

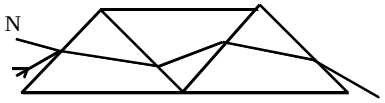
$$\frac{1}{f_3}=-\frac{2}{3f}$$

18. A quartz prism can produce a minimum deviation g in a light beam, then the minimum deviation δ produced by three prisms combined together is

1)2δ 2)0 3) δ 4) 3δ

Ans:3

Sol:



Total deviation produced by the combination of prisms $S_{Total}=\delta-\delta+\delta=\delta$

19. A compound microscope consists of an objective lens with focal length 1.0 cm, eyepiece of focal length 2.0 cm and a tube length 20cm.Find the magnification of the microscope

1)100 2)200 3)250 4)300

Ans:3

Sol: $m=\frac{L}{fo}\times\frac{D}{fe}$

$m=250$

20. Focal length of the lenses of an astronomical telescope are 50cm and 5 cm length of the telescope, when the image is formed at the least distance of distinct vision is

1)45cm 2)55cm 3) $\frac{275}{6}cm$ 4) $\frac{325}{6}cm$

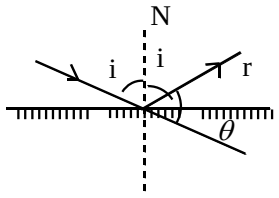
Ans:4

Sol: $L=f_0+\frac{f_eD}{f_e+D}=\frac{325}{6}cm$

21. A ray of light travelling in the direction $\frac{1}{2}\left(\hat{i}+\sqrt{3}\hat{j}\right)$ is incident on a plane mirror. After reflection, it travels along the direction $\frac{1}{2}\left(\hat{i}-\sqrt{3}\hat{j}\right)$.The angle of incident is

Ans: $i=30^0$

Sol:



$i+i+\theta=180^0$

$2i=180-\theta\, but\, i=\frac{180-\theta}{2}$

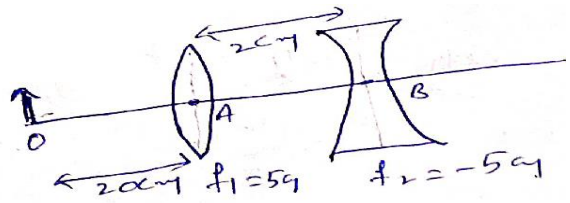
$$\cos\theta=\frac{\left(\frac{i+\sqrt{3}\hat{j}}{2}\right).\left(\frac{\hat{i}-\sqrt{3}\hat{j}}{2}\right)}{\left|\frac{\hat{i}+\sqrt{3}\hat{j}}{2}\right|\left|\frac{\hat{i}-\sqrt{3}\hat{j}}{2}\right|}$$

$$\cos\theta=-\frac{1}{2}$$

22. What is the position and nature of image formed by lens combination shown in figure? (f_1, f_2 are focal lengths)

Ans: 70 cm right of second lens

Sol:



First lens

$$\frac{1}{v_1}-\frac{1}{u_1}=\frac{1}{f_1}$$

$$\mu_1=-20cm;\ f_1=5cm$$

$$v_1=\frac{20}{3}cm$$

Second lens

$$\mu_2=1-2cm$$

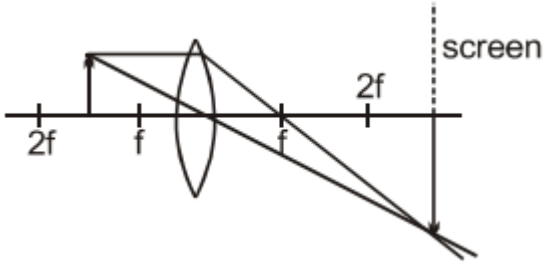
$$\mu_2=6.67-2=\frac{14}{3}cm$$

(or)

$$\mu_2=\frac{20}{3}-2=\frac{14}{3}cm$$

$$\frac{1}{v_2}-\frac{1}{\mu_2}=\frac{1}{f_2}$$

23. Formation of real image using a biconvex lens is shown



If the whole set up is immersed in water without disturbing the object and the screen positions, what will one observe on the screen?

Ans: the image shift father away

Sol: $$\frac{1}{f}=\left(\frac{\mu_2}{\mu_1}-1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$$

If the setup is immersed in meter $f\uparrow$, the image shift .Another away from the lens

24. A giant refracting telescope at an observatory has an objective lens of focal length 15m.If an eye piece of focal length 1.0 cm is used, what is the angular magnification of the telescope?

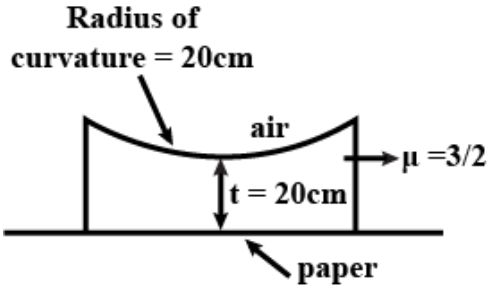
Ans: 1500

Sol: $$m=\frac{fo}{fe}$$

$fo=15m$

$fe=1cm$

25. In the given figure, a plano-concave lens is placed on a paper on which a flower is drawn. How far above its position does the flower after to be?



Ans:10cm below the curves surface(or)10cm above the actual position of flower

Sol: $u=-20cm$

$\mu_1=3/2;\mu_2=1$

$R=+20cm$

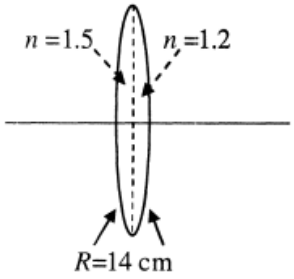
$\frac{\mu_2}{v}-\frac{\mu_1}{u}=\frac{\mu_2-\mu_1}{R}$

$v=-10cm$

26. A bi-convex lens is formed with two thin plano-convex lenses as shown in the figure. Refractive index n of the first lens is 1.5 and that of the second lens is 1.2. Both the curved surface are of the same radius of curvature R=14 cm. For this bi-convex lens, for an object distance of 40 cm, the image distance will be

Ans:40cm

Sol:



$\frac{1}{f}=\left(\frac{\mu_L}{\mu_a}-1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

First law:

$\mu_L=1.5$

$R_1=14cm$

$R_2=\infty$

$\frac{1}{f_1}=\frac{0.5}{14}$

Second law:

$\mu_L=1.2$

$R_1=\alpha$

$R_2:-14cm$

$\frac{1}{f_2}=\frac{0.2}{14}$

$\frac{1}{f}=\frac{1}{f_1}+\frac{1}{f_2}=14cm$

27. A plano convex lens (focal length f_2, refractive index μ_2, radius of curvature R)fits exactly into a plano-concave lens (focal to length f_1,refractive index μ_2) The focal length radius of curvature R. Their plane surfaces are parallel to each other. Then, the focus length of the combination will be

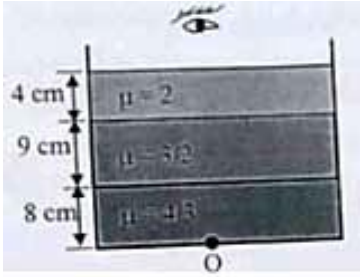
Ans: The focal length of the combination of lens= $\frac{R}{\mu_2-\mu_1}$

Sol: $\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}$

$$\frac{1}{f_1}=(\mu_1-1)\left(\frac{1}{\infty}-\frac{1}{R_1}\right)=-\left(\frac{\mu_1-1}{R_1}\right)$$

$$\frac{1}{f_2}=(\mu_2-1)\left(\frac{1}{R_2}-\frac{1}{\infty}\right)=\frac{\mu_2-1}{R_2}$$

28. A tank contains three layers of immiscible liquids as shown in figure. The first layers of water with refractive index $\frac{4}{3}$ and thickness 8cm.The second layer is oil with refractive index $\frac{3}{2}$ and thickness 9cm while the third layer is of glycerin with refractive index 2 and thickness 4 cm. The apparent depth (in cm)of the bottom of the container is_____



Ans:14cm below the glycerin-air

Sol: Not shift

$$S=t_1\left[1-\frac{1}{\mu_1}\right]+t_2\left[1-\frac{1}{\mu_2}\right]+t_3\left[1-\frac{1}{\mu_3}\right]$$

$S=14cm$

29. An air bubble in a glass sphere $\mu=1.5$ is situated at a distance 3cm from a convex surface of diameter 10cm.At what distance from the surface will be bubble appear____

Ans:-2.5cm

Sol: $\frac{\mu_1}{v}-\frac{\mu_2}{u}=\frac{\mu_1-\mu_2}{R}$

$\mu_1=1$

$\mu_2=1.5=\frac{3}{2}$

$u=-3\text{cm}$

R= -5cm

30. A man stands symmetrically between two large plane mirror fixed to adjacent walls of a rectangular room the number of images formed are_____

Ans: 3

Sol: $\theta=90^0$

$rn=\frac{360^0}{\theta}=\frac{360}{90}=4$

$n=4-1$

$n=4-1=3$

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